MAINE
REMEDIAL ACTION GUIDELINES (RAGS)
FOR
SITES CONTAMINATED WITH HAZARDOUS SUBSTANCES

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF REMEDIATION AND WASTE MANAGEMENT

Revision Date: May 8, 2013

Approved: ____________________ May 10, 2013
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Maine Remedial Action Guidelines for Sites Contaminated with Hazardous Substances (RAGs)

Revision of May 8, 2013

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Maine Remedial Action Guidelines for Soil Contaminated with Hazardous Substances (RAGs)
Revision of May 8, 2013

I. Disclaimer

This guidance document provides an approach that is generally acceptable to DEP for determining contaminant specific clean-up goals for soil, groundwater and indoor air that is contaminated with hazardous substances. These guidelines are not rules and are not intended to have the force of law. This guidance does not create or affect any legal rights of any individual, all of which are determined by applicable statutes and law. This guidance does not supersede statutes or rules.

II. Introduction and Purpose

Maine law charges the Commissioner of the Department of Environmental Protection (DEP) with abating pollution in order to protect public health and welfare. This guidance is intended to increase the consistency of remediation decisions in Maine and certainty for the regulated community. This document provides guidance on target clean-up levels for contaminants in soil, indoor air and groundwater at remediation sites to prevent undue impacts to public health. The Remedial Action Guidelines for Maine (RAGs) in this guidance are also intended to be used as a screening tool to determine which sites warrant mitigation. In addition, this guidance contains links to multi-contaminant calculators that should be used to clear sites for reuse (close-out sites) once remediation is completed.

The RAGs and multi-contaminant calculators were developed with toxicological assistance from the Maine Department of Health and Human Services' Center for Disease Control and Prevention (CDC). These guidelines are consistent with, and support the CDC and DEP's "Guidance for Human Health Risk Assessments for Hazardous Substance Sites in Maine", which were revised in April of 2013 (Risk Manual), and which may be found on DEP's website at http://www.maine.gov/dep/spills/publications/guidance/index.html. A project lead may choose to use these Remedial Action Guidelines to simplify derivation of clean-up guidelines for sites and to speed-up the decision making process. Alternatively, the project lead may decide to use the risk assessment procedures in the Risk Manual to determine whether site action is warranted, determine target clean-up goals, and determine if the site can be closed out.

III. Applicability

A. Applicable Programs & DEP Approval Process

This procedure applies to determining contaminant specific clean-up goals, known as Remedial Action Guidelines (RAGs) for contaminated media at sites in Maine for the following DEP programs. In general, DEP reviews an applicant's proposal, and reaches agreement on appropriate RAGs for a specific site. DEP determinations as to when soil clean-up levels will be protective of public health and welfare are made in clean-up decisions in the form of DEP Orders, Administrative Agreements, Consent Agreements, and other legally binding decision documents.

Consult staff in these programs to determine the administrative procedures for review and approval of site specific clean-up goals. Details on each of these programs if available on DEP's website at: http://www.maine.gov/dep/programs/.

1. Uncontrolled Hazardous Substance Sites.

   The project lead may use this procedure to determine clean-up levels at an Uncontrolled Hazardous Substance Site (Uncontrolled Site) under 38 MRSA §1364.5. The Uncontrolled Sites Program (USP) directs the investigation and removal of threats to the public health, safety or welfare that are posed by hazardous substances at sites. Basically, the USP is the state equivalent to the federal Superfund Program. At DEP lead sites, DEP establishes clean-up goals in formal DEP Decision Documents, after a management review meeting.

2. Voluntary Response Action Program.

   Maine's Voluntary Response Action Program (VRAP) , under 38 MRSA § 343-E, allows applicants to voluntarily investigate and clean-up properties to the DEP's satisfaction in exchange for protections from future DEP enforcement actions. The project lead may use this guidance to determine clean-up levels for a site in the VRAP.

3. Brownfields.

   The project lead may use these procedures to determine clean-up levels at a Brownfields site. The Brownfields program provides grants to assist the assessment and remediation of "[r]eal property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant", pursuant to the Business Liability Relief and Brownfields Revitalization Act, 42 U.S.C. §§ 9601-9628.

4. Superfund/CERCLA.

   At sites subject to clean-up under the federal Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. §9601 et seq. of 1980, as amended (CERCLA or Superfund), clean-up levels are determined by Applicable or Relevant and Appropriate Requirements (ARARs) and the "Nine Criteria" found in 40 CFR 300.430 of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The DEP will recommend that EPA "consider" using this guidance to establish clean-up goals for sites being investigated and remediated under Superfund in Maine, including Department of Defense sites. Site specific remediation decisions are finalized in a Record of Decision for each site.

5. RCRA.

   At sites subject to RCRA corrective action, these guidelines may be used when clean closure was not achieved (i.e., when hazardous waste or hazardous matter residues remain in the environment despite best efforts). The DEP's RCRA program may use this procedure to, in part, determine whether media at a site pose a threat to the public health, safety or welfare, as defined by the Maine Hazardous Waste, Septage and Solid Waste Management Act and associated regulations, 06-096, Chapters 850 through 857. These rules, authorized under the EPA's RCRA program, built upon the minimum Federal rules based on Maine's environment and strong reliance on groundwater for drinking water. The Hazardous Waste Program is a preventative program intended to require the proper management of chemicals and waste, and the prevention of their release into the environment. The Hazardous Waste Management rules generally require releases of hazardous waste and constituents to be removed, and where not removed, remediated to allow for unrestricted future use whenever possible. Site specific remediation clean-up decisions are made in DEP Orders and Licenses. These decisions consider the RAGs as well as other information including but not limited to background levels, regulatory requirements, ecological effects, additive and synergistic effects of multiple contaminants, quality of data and post closure licensing requirements when establishing clean up goals at RCRA sites.

6. Not Applicable to other DEP Programs.

   DEP does not intend that these guidelines be used by programs that are not listed above.

7. Relation to Beneficial Reuse of Remediated Debris

   Remediated soils or other debris may qualify for a subsequent reuse, such as fill, even though pollutants in the material may exceed normal background concentrations.

   (a) Hazardous Waste
   The beneficial reuse of contaminated material that is classified as a hazardous waste is subject to the hazardous waste laws described in section III.A.5 above, and the project lead should consult with the DEP's RCRA staff (207-287-2651) regarding its reuse requirements.

   (b) Other residuals
   The beneficial reuse of contaminated material that is not classified as a hazardous waste is subject to the DEP's Solid Waste Program rules. Specifically, if the material is to be beneficially used for Agronomic Utilization, as say topsoil, fertilizer, soil amendment, or for any other plant growth purpose, then the reuse is subject to the solid waste rules at 06-096 CMR Chapter 419 - Agronomic Utilization of Residuals . If the material is to be used for any another purpose, such as fill or a building material, then that activity would be subject to the solid waste rules at 06-096 CMR Chapter 418 -: Beneficial Use of Solid Wastes. These rules generally have exemptions to allow the storage and reuse of materials on the site of generation, if DEP is the project lead. See

the rules and discuss with the DEP's solid waste staff (207-287-2651) any intended off-site storage or reuse of materials from a remediation project.

B. Applicable Media

This procedure is applicable to determining clean-up levels for soils, groundwater and/or indoor air that is contaminated by hazardous substances. Included in this procedure is clean-up necessary to protect public health impacts from direct contact with soil, incidental ingestion (eating) of soil, inhalation of fugitive dusts released from soil, transfer of contaminants from soil into groundwater, ingestion and contact with groundwater, and inhalation of indoor air. For purposes of this guideline, soil includes hydric soil.

This procedure does not apply to establishing clean-up guidelines for public drinking water supplies, surface water or any other media that are not discussed above.

C. Applicable Pollutants and Contaminants

1. Applicable to Hazardous Substances.

   This procedure is applicable to determining clean-up levels for media contaminated by hazardous substances, including waste oil.

2. Applicable to Mixtures.

   The procedure is applicable to clean-up levels for media contaminated by a mixture of hazardous substances and petroleum.

3. Not Applicable to Petroleum Only.

   This procedure does not apply to media that are contaminated with only petroleum. For media that are contaminated with petroleum but not hazardous substances, refer to DEP's Remediation Guidelines for Petroleum Contaminated Sites in Maine[1]. For purposes of this section, petroleum includes gasoline, aviation fuels, methyl tertiary butyl ether (MTBE), kerosene, #2 heating oil, other heating oils including heavy oils, diesel fuel, or other comparable petroleum hydrocarbons, and gasoline-ethanol blends with 15% ethanol or less. Petroleum does not include waste oil.

D. Applicable Site Types

1. Applicable Routes of Exposure

   This guidance is specifically developed for sites or operable units with the routes of exposure that the DEP and Maine CDC identified as the most likely to create the greatest risk from contaminants in soil, groundwater or air. These routes of exposure are:

[1] Petroleum clean-up guidance is available on DEP's website at: http://www.maine.gov/dep/spills/petroleum/

a. Ingestion - Incidental ingestion (eating) of contaminated soil while playing or working in contaminated soil or ingestion of contaminated water;

b. Skin Contact - Incidental dermal (skin) contact with contaminated soil while playing or working in contaminated soil. This route also includes incidental dermal (skin) contact with contaminated groundwater while excavating;

c. Volatilization/Dust Breathing - Transfer of contaminants from soil into the ambient air space over the contaminated soil area through evaporation and/or suspension of contaminated soil particles, and subsequent breathing of the contaminated air;

d. Groundwater Drinking - Transfer of Contaminates from soil to groundwater and subsequent ingestion (drinking) of the groundwater; and

e. Vapor Intrusion and Breathing - The transfer of contaminants from soil and/or groundwater into the air inside a building, and the breathing of that air.

f. Other Routes of Exposure - There are other potential exposure routes, but generally they will not pose a greater risk than the pathways already identified. The one exception is volatilization of contaminants from soil to trench air, which cannot be generically modeled. However, under site-specific circumstances, at some sites other pathways may be important and should be considered on a site-specific basis. For example, if a person was only exposed to metals at an agricultural site via plant uptake and subsequent ingestion of the plants, then site specific target clean-up goals would need to be developed for that route of exposure and scenario.

2. Applicable Exposure Scenarios

As described in detail in section VII.E on page 19, the RAGs apply to sites with the following exposure scenarios for soil: Leaching to Groundwater, Residential, Recreational/Park User, Outdoor Commercial Worker, and/or Construction/Excavation Worker. For air, RAGs are developed for residential or commercial exposures. Finally, RAGs were developed for consumption of groundwater as drinking water and exposure to groundwater by construction workers. These are the scenarios that the DEP and Maine CDC identified as the most likely to represent typical exposure situations in Maine.

E. Not Applicable to Ecological Risk

This procedure applies to soil clean-up guidelines protective of human health impacts only. This guidance is not applicable to ecological impacts. This guidance is not applicable to ecological impacts. If the Department believes that hazardous substances in soils pose significant risk to ecological receptors it may require that the project lead conduct an ecological assessment before the RAGs are applied at the site. DEP generally requires an ecological assessment if evidence indicates that a current or future potential exists for exposure of ecological receptors to contaminants from the site. Evidence includes visible physical evidence (sheens or neat product, etc.) or analytical data that contaminants from the site are impacting surface water, sediment, wetlands, or biota. Evidence also includes runoff or other exposure pathways that will likely result in ecological impacts. Evidence may also include data suggesting potential adverse impacts to terrestrial biota, such as contaminants that can bioaccumulate and that are within the top two (2) feet of soil. Additional guidance on assessing ecological risk at contaminated sites is available at: http://www.epa.gov/oswer/riskassessment/tooleco.htm.

F. Not Applicable to Selection of COPCs for Full Risk Assessment

The RAGs should not be used in selecting Contaminants of Potential Concern (COPCs) for a risk assessment conducted in accordance with the Maine "Guidance Manual for Human Health Risk Assessment at Hazardous Substance Sites" , since RAGs are set at an Incremental Lifetime Cancer Risk (ILCR) of 10^{-5} or a Hazard Quotient (HQ) of 1. Risk-based concentrations for use in selecting COPCs should reflect an ILCR of 10^{-6} and non-carcinogenic HQ of 0.1. The use of risk-based concentrations at these target risk and hazard levels ensures that contaminants contributing significantly to risk and hazard are included in the quantitative assessment. Because the intent of the COPCs selection process is to generate a conservative list of contaminants requiring quantitative evaluation, recommended screening criteria are conservative so as not to omit contaminants that may contribute significantly toward cumulative site risk.

IV. Definitions

A. Background Contaminants

"Background Contaminants" means those contaminants that are not due to the release of contaminants at the Hazardous Substance Site. The background contaminants may be naturally occurring (e.g. lead) or man-made (e.g., DDT) Note Hazardous Substance Site activity may chemically transform or release naturally occurring substances into other environmental media. These additional concentrations of the naturally occurring substance that are released from the Hazardous Substance Site activity are not representative of natural background concentrations. For example, biological degradation of buried organic materials such as tannery wastes at a site can deprive the subsurface of oxygen, which in turn reduces the pH, causing metals such as arsenic to become soluble in the groundwater. In this case, the increase in arsenic in groundwater may be considered a site-related contaminant and a consideration in remediation of the site, even though it came from the parent rock, rather than the site waste.

B. Background Locations

"Background Locations" means areas with relevant media that are similar to the Hazardous Substance Site (i.e., similar soil characteristics), that have been influenced to the same degree by regional deposition, runoff, or other contaminant inputs, but where contaminants released at the Hazardous Substance Site have not come to be located. Some chemicals may be present in background locations as a result of both natural and man-made conditions (such as naturally occurring arsenic and arsenic from pesticide applications or mining operations).

C. Contaminant

"Contaminant" means hazardous substance.

D. Contaminant of Potential Concern (COPC)

"Contaminant of Potential Concern" or "COPC" means a contaminant that has been released at a site and further risk evaluation is warranted.

E. Environmental covenant; covenant

"Environmental covenant" or "covenant" means a servitude arising under an environmental response project and documented in a recordable instrument (usually a deed) that imposes activity and use limitations on a parcel of land. "Environmental covenant" does not include a municipal ordinance, a voluntary or other remedial action plan or action plan condition, or an administrative or judicial order, even if it imposes activity or use limitations.[2]

F. Exposure Pathway

"Exposure Pathway" means the route a contaminant takes from its source (where it began) to its end point, and how people can come into contact or otherwise are exposed to the contaminant. An exposure pathway has five parts: a source of contamination (such as a leaking tank); an environmental medium and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). An exposure pathway is termed a completed exposure pathway only when all five parts are present[3].

G. Exposure Point

"Exposure Point" means a location of potential contact between a person and a hazardous substance.

H. Exposure Point Concentration (EPC)

"Exposure Point Concentration" or "EPC" means the concentration of contaminant that an individual would be exposed to in the relevant medium at the exposure point.

I. Hazard Index (HI)

The "Hazard Index (HI)" is the sum of the Hazard Quotients and is used to calculate whether an adverse health risk, other than cancer, might occur to an

[2] 38 Maine Revised Statutes Annotated (MRSA) section 3002, subsection 4.
[3] Adopted from the Agency for Toxic Substances and Disease Registry (ATSDR) Glossary of Terms: http://www.atsdr.cdc.gov/glossary.html#G-D-

individual exposed to contaminants at a site. Specifically, the HI applies to non-carcinogenic effects and means the sum of hazard quotients for substances that affect the same target organ or organ system. The Hazard Index is estimated as the Average Daily Dose or Average Daily Exposure for the exposure period divided by the Reference Dose or Reference Concentration, respectively. The Hazard Index is also described as a weighted sum of the exposure measures for the mixture component chemicals. The "weight" factor according to dose addition should be a measure of the relative toxic strength, sometimes called "potency."

J. Hazard Quotient (HQ)

The "Hazard Quotient (HQ)" is a calculation used to determine whether an adverse health risk, other than cancer, might occur to an individual exposed to a given contaminate at a site. Specifically, the HQ applies to non-carcinogenic effects and is the ratio of estimated site-specific exposure to a single chemical from a site over a specified period (exposure level) to the estimated daily exposure level at which no adverse health effects are likely to occur (toxicity guideline).

K. Hazardous Substance

"Hazardous Substances" are chemicals that might pose a health risk if individuals are exposed to them above a specific dose. For purposes of this guidance, Hazardous Substance has the same meaning as defined under *the Maine Uncontrolled Hazardous Substance Sites Act*, 38 M.R.S.A.,§1362. 1, which defines "Hazardous Substances" as:

A. Any substance identified by the Board of Environmental Protection under section 1319-O;
B. Any substance identified by the Board of Environmental Protection under section 1319;
C. Any substance designated pursuant to the United States Comprehensive Environmental Response, Compensation and Liability Act of 1980, Public Law 96-510, Sections 101 and 102 (Superfund);
D. Any toxic pollutant listed under the United States Federal Water Pollution Control Act, Section 307(a);
E. Any hazardous air pollutant listed under the United States Clean Air Act, Section 112;
F. Any imminently hazardous chemical substance or mixture with respect to which the Administrator of the United States Environmental Protection Agency has taken action pursuant to the United States Toxic Substances Control Act, Section 7; and
G. Waste oil as defined in section 1303-C.

L. Hazardous Substance Site

"Hazardous Substance Site" or "site" means any site where hazardous substances have come to be located, and are subject to any of the following DEP programs: Brownfields, Federal Defense Facilities, Resource Conservation and Recovery Act (RCRA), Uncontrolled Hazardous Substance, Voluntary Response Action Program (VRAP), or Superfund.

M. Incremental Lifetime Cancer Risk (ILCR)

The "Incremental Lifetime Cancer Risk" or "ILCR" is the method used to calculate the increased, upper-bound risk of cancer that might occur to an individual exposed to contaminants at a site, with the exposure averaged over a lifetime. Specifically, ILCR means the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a contaminant.

N. Neat material

"Neat material" means liquid or solid hazardous substances which occur in a pure or nearly pure form and which may or may not be in a container. Neat material is distinct from dissolved contamination.

O. Project Lead

The "project lead" is the agency, group, or person that is the primary leader for remedial activities at the site and generally hires the contractor that undertakes the remediation. The project lead may be the site owner/operator or other Potential Responsible Party, a state or federal agency, a developer, or other person.

P. Public Water

"Public Water", or "Public drinking water supply" means any well or other source of drinking water that furnishes water for human consumption for 15 service connections, regularly serves an average of at least 25 individuals daily at least 60 days out of the year, or supplies bottled water for sale.

Q. Urban Fill

"Urban fill" means soil mixed with other materials that has been placed over an area for the purpose of modifying the elevation of the land surface to facilitate development of the property or properties and that are unrelated to a specific property activity or past property use. Components in the soil matrix that comprise Urban fill may include a variety of identifiable materials including brick, cement, wood, wood ash, coal, coal ash, boiler ash, clunkers, other ash, asphalt, glass, plastic, metal, inert demolition debris, and roadside ditch materials. Certain urban areas of Maine, such as the Back Bay Area of Portland, have large quantities of Urban Fill present. Many properties in Maine have smaller quantities of Urban Fill present, including developed properties in rural areas of the state. To distinguish urban fill from site related contaminants, soil descriptions should include the components of fill materials that are present and the sites Conceptual Site Model should include the extent or approximate extent of the materials both vertically and horizontally.

V. Responsibilities

A. Project Leads

The primary leader for remedial activities at a hazardous substance site should develop media specific clean-up goals for DEP's consideration that are consistent with this guidance or the Risk Manual.

B. BRWM Staff

DEP program staff should encourage adherence to this guidance in order to speed up development of clean-up goals at sites. Staff should alert their supervisors when alternative approaches are proposed for a site.

C. BRWM Unit Supervisors

Unit supervisors should ensure that remediation decisions are consistent within their units. Unit supervisors must receive pre-approval from the Division or Bureau Director before recommending any clean-up approvals that vary from this guidance.

D. BRWM Division Directors

Division Directors are responsible for ensuring that the staff in their division is trained in how to use this procedure and that soil clean-up guidelines are consistently applied within its program and between other divisions to which this procedure is applicable. Division Directors will consult with each other on variances to this guidance in their respective programs, generally through a project specific management review meeting.

VI. Where RAGs Fit in the Site Assessment and Remediation Process

A. Introduction

Establishing contaminant specific RAGs is one part of the site investigation and remediation process. The focus of this guidance is on development and application of RAGs. In order to provide context, however, this section provides a brief overview of the site assessment and remediation steps that must come before employing the RAGs. This overview is not a primer on those processes. Guidance for site assessment and remediation is available on the DEP website at: http://www.maine.gov/dep/spills/publications/guidance/index.html. Further, the legal requirements for the handling, storage, treatment, and disposal of contaminated materials at Hazardous Substance Sites is not described in this guidance.

B. Emergency Removal

Before employing RAGs, acute hazards posing imminent risk to public health or welfare should be subject to emergency removal. Before implementing RAGs, the following minimum actions should be taken at sites:

1. Imminent threats to public health or safety (such as the threat of explosions) must be removed,
2. hazardous substances stored in unmarked containers, containers of questionable integrity, inappropriate containers, or containers that are otherwise in violation of hazardous materials or hazardous waste laws must be removed, and

3. neat materials not properly stored and hot spots must be recovered and removed. In addition, the RAG values for contaminants in **Table 1** were capped at ceiling of 1% (10,000 ppm)[4]. That is, DEP requires that some upper level of soil contamination must be addressed at all sites even though calculated risks from the applicable pathways are expected to be acceptable.

Emergency removal units often leave residual contamination at the site, which would be subject to this guidance. Note that when contamination can be readily identified, recovered and removed for less cost than investigating the site, then the contamination should simply be removed, per DEP approvals. Additionally, even if RAGs are not exceeded, when feasible the DEP may require removal of substances that present a nuisance[5].

C. Conceptual Site Model Development

Prior to using the RAGs, the project lead will need to develop a conceptual site model (CSM) for DEP approval, using guidance such as ASTM E1689-95(2008) Standard Guide for Developing Conceptual Site Models for Contaminated Sites, as updated. This Guideline defines a CSM as *"a written or pictorial representation of an environmental system and the biological, physical and chemical processes that determine the transport of contaminants from sources through environmental media to environmental receptors within the system."*

The CSM is a dynamic tool that directs the project lead's investigation[6] and risk mitigation decisions at the site. The CSM should be developed as early in the assessment process as possible (it does not require site specific hydrogeologic or laboratory data) and updated as new information becomes available. For instance, the CSM will be used to focus site investigation work plans (SOW, SSQAPP, etc.) on the collection of data needed to support a site specific risk-based decision. The data obtained may change the understanding of the site's risk, and if so, the CSM should be revised accordingly, and then be used to assess risk mitigation options.

According to the ASTM Guideline, developing a CSM includes the following steps:

1. Assembling the Available Information
2. Identifying Contaminants of Potential Concern (COPC)
3. Establishing Background Conditions

[4] This ceiling does not apply to iron or aluminum for which background concentrations often are greater than 1%. The ceilings for iron and aluminum are set at 90% of background or unity, whichever is lower.

[5] The Free (online) Dictionary by Farlex provides the following legal definition of nuisance: "The two types of nuisance are private nuisance and public nuisance. A private nuisance is a civil wrong; it is the unreasonable, unwarranted, or unlawful use of one's property in a manner that substantially interferes with the enjoyment or use of another individual's property, without an actual Trespass or physical invasion to the land. A public nuisance is a criminal wrong; it is an act or omission that obstructs, damages, or inconveniences the rights of the community."

[6] ASTM E1903-11 (Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process) is a good reference for applying a CSM to an environmental site assessment.

4. Characterizing Areas of Concern/Sources (AOC)
5. Identify Migration Pathways
6. Identify Receptors including human and obvious ecological receptors

The CSM narrative should *concisely* (one to three pages) focus on the site's contaminant source, migration pathway, and potential receptors. The narrative summarizes site information and should include a description of:

- The site,
- potential sources (containers, disposal units) and other areas of concern,
- primary release mechanisms (leaking containers, spills, disposal areas) and secondary sources (high concentrations in soil and/or groundwater),
- a list of site related contaminants, their distribution, and background conditions
- a discussion of actual or potential migration pathways, including fate and transport mechanisms and the hydrogeologic setting within the flow field), and
- potential ecological and/or human receptors.

The narrative is typically supported by several figures and perhaps a table, depending on site complexity. The CSM can be a stand-alone document or part of another site document, but detailed description of hydrogeology, properties of contaminants, contaminant distribution, and so forth should be included in other documents or sections, rather than the CSM. Its language should be understandable by both investigators and future property owners.

D. Detection Levels & Data Quality Objectives

It is important to consider the site's clean-up goals when establishing the Data Quality Objectives[7] (DQOs) for a site sampling plan. For most sites, detection below the RAG levels should be possible if the appropriate sampling and testing procedures are used. The Practical Quantification Limit (PQL) for a given sample will depend on a combination of factors including matrix interferences, analytical method, instrument sensitivity and lab precision. Under some site-specific circumstances, however, a given RAG may be below the level that can be accurately measured using current sampling and analytical protocols. Contact DEP (207-287-2651) for further guidance in these cases, or for additional help in establishing site DQOs.

E. Assessing Vapor Intrusion (VI)

Vapor intrusion (VI) is the volatilization of hazardous substances from contaminated soil or groundwater into buildings. Because VI potential is dictated

[7] Data quality objectives, or DQOs, are a description of the data that that must be obtained during a site investigation in order to support decisions regarding the site, such as the potential risk posed by the site, and how to address those potential risks. DQOs are based on the end use of the data. For more information, see USEPA Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4), EPA/240/B-06/001, February 2006.

by numerous factors, contaminant levels in soil or groundwater are not a reliable indicator of VI potential. Therefore, DEP was not able to develop soil guidelines that are protective of the vapor intrusion pathway. Rather DEP considers measurement of contaminants in soil vapor and indoor air to be the best representation of VI potential and risk.

To pose a risk, Vapor Intrusion (VI) requires three components: a source, an inhabitable building, and a pathway from the source to the building interior. The Conceptual Site Model for the site should include an assessment of the vapor's susceptibility to biodegradation, since this greatly influences its potential to intrude into buildings. For persistent compounds, such as most chlorinated solvents:

- vapors will not necessarily move in the same direction as groundwater flow; rather vapors often travel along preferential pathways, such as utility corridors;
- vapors moving in groundwater or bedrock are a potential indoor air risk unless they are overlain by at least 10 feet of low permeability overburden;
- investigations should move out from the source of contamination along the preferential pathway to an occupied building; and
- Once a completed pathway has been shown to exist with a soil gas investigation, then subslab/ perimeter soil gas samples should be taken. If these samples indicate concentrations at ten times (10X) the concentrations in Table 2, then unless otherwise approved by the DEP based on site specific factors, indoor air samples should be obtained.

For compounds that rapidly degrade in the subsurface, such as petroleum compounds:

- Vapors need a continuing source of vapors so are more likely to follow groundwater flow, rather than utility corridors; and
- Indoor air sampling is only warranted when oil saturated soil or shallow grossly contaminated groundwater is adjacent to a receptor building

Indoor air samples should be analyzed only for COPCs, as determined by the conceptual site model. Mitigation actions are warranted for concentrations in indoor air (not soil gas) that exceed the values in Table 2.

Additional guidance for Vapor Intrusion Investigations is available from DEP's Vapor Intrusion Evaluation Guidance 1/14/2010 (note, this guidance is currently being revised. Target levels and investigation approaches in this guidance supersede any conflicts with the 1/14/2010 VI guidance). If soil clean-up is necessary to prevent VI, rather than diverting the vapors themselves, then the project lead must develop site-specific remediation goals in consultation with the DEP to meet the applicable indoor air targets shown in Table 2.

F. The Mercury RAGs and Sampling for Mercury

The toxicity of mercury varies with the other elements that it is complexed with. In this guidance, CDC developed soil RAGs for mercuric chloride (CAS 7487-94-7). The toxicity information for mercuric chloride is also applicable to some other inorganic compounds such as mercuric salts. The soil RAGs for "Mercuric chloride and other inorganic mercury compounds" is not appropriate for organic forms of mercury, such as methyl mercury (CAS 22967-92-6). The soil RAGs for "Mercuric chloride and other inorganic mercury compounds" is also not applicable to metallic mercury or elemental mercury (CAS 7439-97-6). There are no oral toxicity data for elemental mercury, so it was not possible to develop a soil guideline. There is an inhalation toxicity value, and elemental mercury should be evaluated for vapor intrusion (see section VI.E on page 12) if it is a Contaminant of Potential Concern at the site, in which case the IAT RAG in Table 2 should be applied. In order to use the RAGs for mercury, the exposure point concentration must be expressed as speciated mercury, rather than total mercury.

G. The Chromium RAGs and Sampling for Chromium

The toxicity of chromium varies with its valence state. Hexavalent Chromium is much more toxic than trivalent chromium. In order to use the soil RAGs for chromium, the exposure point concentration must be expressed as hexavalent (Chromium (+6), CAS 18540-29-9) and trivalent chromium (Chromium (+3), CAS 16065-83-1), rather than total chromium.

H. Exposure Point Concentrations

RAGs are compared to the Exposure Point Concentration (EPC) for each medium at the site. The EPC is the concentration of a contaminant in a specific medium at an exposure point, such as a well or soil in a residential yard. Unless otherwise approved by DEP, the EPC should be set at the 95th upper confidence interval of the mean. If this value exceeds the maximum value in the dataset, then use the maximum value instead. In cases where there is insufficient data to run a statistical analysis then the EPC should be set at the maximum value in the dataset. In the case of Multi-Incremental Sampling (i.e., establishing grid-based Decisions Units and compositing soil samples within a Decision Unit), if the Decision Unit represents the EPC, then the composite result is directly compared to the RAG. If an EPC is represented by multiple Decision Units, then the 95th upper confidence interval of the mean of the Decision Unit samples applies as described above. Further guidance on establishing EPC is available from EPA at: http://www.epa.gov/region8/r8risk/hh_exposure.html#epc.

VII. Determine Target Clean-up Levels Using RAGs

A. Introduction.

Once the procedures in sections VI are completed, then use either this guidance, or the " Maine DEP and CDC April 2013, Revised Guidance For Human Health Risk Assessments for Hazardous Substance Sites in Maine" (Risk Manual) to determine site specific target clean-up levels, by media, at the site. The choice of which procedure to use is at the discretion of the project lead on the clean-up, which may be the site owner/operator, Potential Responsible Party, DEP, EPA, Department of Defense, or other party.

The RAGs in **Table 1** through Table 3 present the number above which remedial action should be taken at a site, and the target clean-up guidelines by medium for hazardous substances commonly encountered at sites in Maine. Contaminants are listed by CAS number and a common name to ensure the correct identification. To determine site specific RAGs, use the following process, which is detailed in the sections below.

1. Exclude background contaminants that were not released by site activities in accordance with section VII.D on page 16).
2. Determine which media are contaminated. For contaminated soil, use **Table 1**, for contaminated indoor air, use Table 2, and for contaminated groundwater, use Table 3.
3. Determine the appropriate land use scenario for the site, considering current and potential future land uses. The descriptions of the scenarios are found in section VII.E on page 19.
4. Finally, determine the lowest applicable value in the column of the table that you are using (or alternative value as determined in section VII.B. or VII.E.1)
5. Plan and undertake the clean-up, if necessary.
6. Following remedial action, the risk calculation workbooks (http://www.maine.gov/dep/spills/publications/guidance/index.html#new_rag) should be used to determine if the residual levels remaining on site are acceptable and the site may be closed-out, or if further action is needed – see section VII.C on page 16.

The following sections discuss in more detail the above process for selecting the appropriate RAG for a given site.

B. Target Risk Level for RAGs

The toxicity of each contaminant will vary due to a variety of factors including the contaminant's chemical and physical properties; the route, duration, and intensity of exposure; and the sensitivity of the exposed people. Consistent with EPA, Maine DEP calculates risk based on Reasonable Maximum Exposure (RME) scenarios. USEPA defines RME as the highest exposure that is reasonably anticipated to occur at a site. RAGs are based on chronic exposure, rather than subchronic or acute exposures.

The goal for site clean-up and closure is to reduce risk posed by contaminants to acceptable levels. Consistent with the Risk Manual, sites are closed out when the cumulative (combined) effects of contaminants at the site do not pose a risk that is greater than a Hazard Index (HI) of 1 by target organ, and an Incremental Lifetime Cancer Risk (ILCR) of greater than 10^{-5}.

The RAGs are established based on exposure to a *single* contaminant in a single media, and at the lower of the Incremental Lifetime Cancer Risk (ILCR) of 10^{-5} or a Hazard Quotient of 1. Risk based values are then adjusted for background and ceiling concentrations, as discussed in section VII.D on page 16 and in section VI.B.3 on page 11. Since contaminants are typically co-located or related daughter products, DEP anticipates that using the RAGs as target clean-up levels, will achieve the site closure risk level for mixtures of chemicals. However, if the project lead determines that due to anticipated residual contaminant mixtures after remediation that an unacceptable risk will likely still occur even if the table 1-3 levels are met, then the lead may wish to employ the risk calculator workbooks in an iterative fashion, to derive alternative, site specific clean-up goals before undertaking remediation.

C. Site Closure Risk Levels and Risk Calculation Workbooks

Consistent with the Risk Manual, sites maybe closed out once the applicable target clean-up levels are obtained and risk calculations demonstrate that, excluding background, the Cumulative (combined) effects of contaminants at the site do not pose a risk to a RME individual that is greater than a Hazard Index of 1 by target organ, and an Incremental Lifetime Cancer Risk of greater than 10^{-5}. Risk calculation workbooks to run these calculations (by simply inputting residual EPCs) are available at: http://www.maine.gov/dep/spills/publications/guidance/index.html#new_rag.

D. Assess Risk Contribution from Background Contaminants

In some cases, background (see definitions in section IV.A and IV.B on page 6) concentrations of contaminants may exceed acceptable clean-up guidelines for soil. The DEP allows the project lead to increase a clean-up level from the risk-based RAG to account for background concentrations.

1. Background Concentrations Policy.

   DEP will not require a clean-up of site soil to be more stringent than the local background concentration. Therefore:

   (a) When the concentration of the substance in the background location exceeds a RAG, then the concentration of the substance in background location will be the clean-up level at the site.

   (b) When the concentration of the substance in the background location is less than a RAG, then the RAG, becomes the clean-up level.

2. Determining Background Concentrations

The methodology used to establish background contamination levels at a site should be reviewed and approved by DEP. Generally, DEP accepts four methods of determining background concentrations:

(a) Site Specific Samples – The most accurate approach is to use representative samples results from the site or similar nearby areas to determine applicable background concentrations. If samples are collected to establish background concentrations, DEP should review and approve the sampling and analysis plan and any statistical methods[8] used in identifying the background level.
(b) Typical Background Values - **Table 1** includes typical Maine background levels. These may be used if there is not better, representative, site specific background data available;
(c) Literature Values - A review and report on published literature or data from similar sites may be appropriate. These may be used if there is no representative, site specific background data available; or
(d) Other - Other scientifically based methods for establishing background may be approved by the DEP, when there is no representative, site specific background data available;.

3. Arsenic Background Concentrations vs. Man-made Sources

Maine soil often contains naturally occurring arsenic above the risk-based RAG. Further, degradation of contaminants or remedial activities at a site may release arsenic from parent materials. If arsenic is identified in on-site soil above the arsenic RAG, determine if is released by site activities, naturally occurring, or both. Arsenic introduced through site activities must be reduced to the greater of the RAG or background concentrations.

4. Background Concentration of Polycyclic Aromatic Hydrocarbons (PAHs)

Table 1 also lists Maine background concentrations for PAHs in rural developed, urban developed areas, and urban fill. PAHs are often elevated in developed areas from historic PAH source materials that are mixed with soil, such as coal, coal or wood ash, degraded asphalt and driveway sealants, other road wear materials, and Polycyclic Organic Matter (POM) from combustion sources that is deposited from air. In 2011-2012 DEP contracted a study of typical background concentrations

[8] At the time of this writing, generally for sample sets large enough to do statistical analysis, DEP recommends calculating the 90% Upper Prediction Limit (UPL) using the most recent PRO-UCL software. Follow the software's recommendations regarding the use of parametric or non-parametric tests and the handling of non-detected concentrations. Consult with DEP when determining which sample results, if any, should be considered outliers. A report on the datasets and statistical methods used to establish background for the RAGs is available at: http://www.maine.gov/dep/ftp/RAGS-Background-Documents/Metals-and-PAH-Background-Study-2012/. Similar statistical approaches should be used with site specific data in order to compare the site specific dataset to the Maine background dataset.

of PAHs in Maine[9], and found that concentrations are different in urban developed areas as compared to rural developed as compared to urban fill. The division between rural and urban datasets was based on the Department of Transportation's (DOT's) definition of urban compact zone. The difference between rural and urban areas is based on DOT's breakdowns, which are shown on Google Earth maps at: http://www.maine.gov/dep/gis/datamaps/statewide_layers/state_urban_compact_areas.kmz.

A soil cover or other barrier, and a soil management plan are usually appropriate for managing potential exposure risks to the Urban Fill material. Urban fill material includes components in the soil matrix that are unrelated to a specific property activity or past property use. The fill material has been placed over an area for the purpose of modifying the elevation of the land surface for the development of the property or properties. Urban fill components in the soil matrix may include a variety of identifiable materials including brick, cement, wood, wood ash, coal, coal ash, ash, boiler ash, clunkers, asphalt, glass, plastic, metal, inert demolition debris, and roadside ditch materials. Certain urban areas of Maine, such as the Back Bay Area of Portland, have large quantities of Urban Fill present. Many properties in Maine have smaller quantities of Urban Fill present, including developed properties in rural areas of the state. Soil descriptions should include the components of fill materials present and the Conceptual Site Model should include the extent or approximate extent of the materials both vertically and horizontally.

The PAH background concentrations in table 1 should not be used at sites that are undeveloped. In these instances, site specific background samples should be collected.

5. Addressing Risk Due to Background

Even though the DEP does not require remediation of media with background contaminants that exceed RAGs, these background contaminants may pose a risk to public health. In these cases, DEP recommends that the site land use and exposures be limited to meet an alternative RAG for the contaminant if feasible. For example, arsenic or PAH levels may pose a risk if a site is used as residential property, but not pose a risk if the site is used as a commercial property. When a property owner determines that remediation or site use restriction are not practical, then the property owner should ensure that potentially affected parties, such as buyers, are at least notified of the health risk from the background contaminant.

[9] AMEC, Summary Report for Evaluation of Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) and Metals in Background Soils in Maine, Prepared for the Maine Department of Environmental Protection (17 SHS, Augusta, ME 04333-0017) November 16, 2012.

E. Application of Exposure Pathways and Scenarios

1. Introduction

The RAG values are organized along three Exposure Pathways: the Soil Exposure Pathway (**Table 1**); the Indoor Air Exposure Pathway (Table 2); and the Groundwater Exposure Pathway (Table 3). Each exposure pathway table, in turn is organized into exposure scenarios: five (5) exposure scenarios for the soil exposure pathway, and two (2) exposure scenarios for each of the Indoor Air and Groundwater Exposure Pathways. RAGs were developed for these exposure pathways and scenarios because they have the greatest potential to cause health impacts at contamination sites typically found in Maine.

The DEP prefers that clean-up levels allow for unrestricted site use, so whenever practicable, clean-up levels must be set at the lowest level of a contaminant for all the exposure scenarios in the RAG tables. Likewise, land use may change in the future, and scenarios protective of all potential future uses should be selected. When DEP finds that it is not practical to meet the lowest clean-up values (usually the residential scenario), DEP may approve clean-up to the target for other scenarios, provided an Environmental Covenant (section VII.F.2, page 24) is in place to restrict site uses that would result in the RAG being exceeded. For instance, for the soil exposure pathway, the Outdoor Commercial Worker, Construction/Excavation Worker, and Recreational/Park User are common alternative land uses to residential use, so RAGs have been developed for these scenarios. Note, that depending on the contaminant, there may be significant differences in RAGs for these scenarios, and RAGs protective of one of these scenarios may not be protective of the other ones.

Following is a general description of the exposure scenarios that are included in the exposure pathway tables. These descriptions are intended to aid the RAGs user in applying the correct exposure scenario for a given site. If there is a significant exposure pathway or exposure scenario that is not covered in the RAGs, but is applicable to the site (e.g. the only exposure to site contaminants would be through eating cattle that graze extensively on plants that have up taken contaminants at the site), then the Risk Manual should be used to assess risk and clean-up goals at the site, rather than these RAGs. Likewise, if the project lead believes any of the assumptions used in developing the RAGs is overly conservative relative to site conditions, then alternative remedial goals should be developed using the Risk Manual procedures unless otherwise specified below.

2. Leaching to Groundwater Exposure Scenario

RAGs, which are protective of human health by the contact/ingestion route do not necessarily prevent continued degradation of groundwater resources. Leaching of contaminants from soil may increase concentrations in groundwater and the contamination plume may spread.

Therefore, DEP also developed RAGs to prevent the transfer of contaminants from soil to an aquifer, such that the contaminants would not exceed the MEGs for groundwater.

Since technically all groundwater in Maine is classified as GW-A, which must be of drinking water quality, whenever practical, the DEP requires that contaminated soil and/or groundwater be remediated to meet the State's Maximum Exposure Guidelines (MEGs) for drinking water (see section VII.E.3 below). The leaching to groundwater RAGs in **Table 1** are concentrations of contaminants in soil that when leached out will not increase concentrations in groundwater of the contaminant above the MEGs 50 feet away from the edge of the source area when the depth to the groundwater table or bedrock, whichever is at the least, is 15 feet or greater. DEP developed the soil guidelines for Leaching to Groundwater using models calibrated with Maine specific leaching data.

In situations where a drinking water source will be used within 50 feet of the contaminated area, or the depth to the water table or bedrock is less than 15 feet, DEP reserves the right to require that a more stringent, site-specific clean-up level be developed for review and approval by the DEP. On other hand, the project lead may choose to use site-specific modeling to generate site-specific soil clean-up targets that are less stringent but still will not cause the MEGs (Table 3) to be exceeded. For more modeling details, see the Technical Support Document for these RAGs at: http://www.maine.gov/dep/ftp/RAGS-Background-Documents/ . Likewise, the project lead may propose test procedures like the direct leaching test "synthetic precipitation leaching procedure (SPLP)"to show that MEGs will not be exceeded, or hydrogeological studies to demonstrate that a historic spill has not contaminated groundwater at the site and is unlikely to do so. Any alternative approach must be reviewed and approved by the DEP (see section III.A, page 1) before being implemented.

3. Residential Exposure Scenarios.

Soils, indoor air and groundwater cleaned to the RAGs for the residential scenario are protective of all residential uses of sites, and exposures at daycares, eldercare and medical treatment facilities. When developing these RAGs, DEP and CDC assumed continuous exposure to children and adults over thirty (30) years as the population passes through childhood and into adulthood.

(a) Soil.

Exposures to soil by incidental ingestion, dermal contact, and inhalation of contaminants in both fugitive dust and ambient air are assumed to occur with a high frequency and high intensity when the ground is not frozen or snow covered, as children and adults play and work in a residential yard and engage in activities that disturb and displace soil (e.g., lawn mowing, gardening, and bike riding).

(b) Indoor Air.

Exposure to contaminants in Indoor Air is through breathing, or inhalation.

(c) Groundwater.

Exposure to drinking water is primarily through ingestion, but a relative exposure factor is used to account for dermal contact and breathing of contaminants in water while showering. For the Residential Exposure Scenario to groundwater, DEP used the Maximum Exposure Guidelines (MEGs) that are developed and updated by the Maine DHHS.

4. Park User Exposure Scenario.

Soil cleaned to the RAGs for the park user scenario is protective of recreational activities at a park, recreational area or other open space. The park user scenario is similar to the residential scenario in that it assumes exposure to children and adults over thirty years. However, the frequency of exposure of recreational activities at a park or other open space is reasonably anticipated to be less than that occurring in a residential yard. Soil exposures are assumed to occur by incidental ingestion, dermal contact, and inhalation of contaminants in fugitive dust and ambient air when the ground is not frozen or snow covered.

5. Commercial Worker Exposure Scenarios.

(a) Outdoor Commercial Worker Exposure Scenario for Soil

Soils cleaned to the RAGs for the outdoor commercial worker exposure scenario are protective of all indoor and outdoor commercial uses of sites, including full-time industrial and maintenance workers whose jobs require that they be outdoors for a portion of the workday such as groundskeepers, loading dock workers, parking lot attendants, and mechanics. This scenario can also be used to conservatively evaluate indoor workers who may be routinely exposed to soil briefly during work breaks and outdoor lunches. In developing these RAGs, DEP and CDC assumed exposures to soil by incidental ingestion, dermal contact, and inhalation of contaminants in fugitive dust and ambient air occurs over 25 years for the work days of the year when the ground is not frozen or snow covered. Contact with soil is assumed to be of lower intensity than assumed for a residential scenario since these workers are unlikely to be displacing soil (i.e., digging).

(b) Commercial Exposure Scenario for Indoor Air

Indoor air that meets the Commercial Indoor Air Guideline is protective of workers at commercial establishments who may be exposed to contaminant from vapor intrusion (VI) into their workplace. The RAGs are based on chronic exposure default factors of 8 hours per day for 250 days per year for 25 years of exposure.

6. Excavation or Construction Worker.

(a) Construction Worker Exposure Scenario for soil

Soils cleaned to the RAGs for the excavation or construction worker scenario are protective of exposures to soil during high intensity soil disturbance activities such as digging, grading, and back-filling for a construction project lasting up to 6 months. This scenario can be used to conservatively evaluate a utility worker or landscaper whose exposure may be as intense as an excavation or construction worker, but is expected to be of a lesser duration than 6 months. Exposures to soil or groundwater by incidental ingestion, dermal contact and inhalation of contaminants on fugitive dust and ambient air are assumed to occur at a greater intensity than that assumed for the outdoor commercial worker due to the degree of soil disturbance and displacement anticipated. It should be noted, however, that DEP and CDC were unable to develop RAGs that predict adherence to air quality standards and guidelines for trench air. OHSA standards and guidelines pertaining to air quality will need to be followed when undertaking trenching activities, even when the construction/excavation worker RAGs are met at a site.

(b) Construction Worker Exposure Scenario for groundwater

Groundwater that meets or is less than the RAGs for the excavation or construction worker scenario are protective of exposures to groundwater during high intensity groundwater disturbance activities such as digging, grading, and back-filling for a construction project lasting up to 6 months. This scenario can be used to conservatively evaluate a utility worker or landscaper whose exposure may be as intense as an excavation or construction worker, but is expected to be of a lesser duration than 6 months. Exposures to groundwater by incidental ingestion, dermal contact and inhalation of contaminants that volatilize into ambient air were included in the RAG development. When the construction worker guideline for groundwater is exceeded at a site, it indicates that procedures should be put into place to warn construction workers to follow OSHA standards, including appropriate monitoring, during construction activities.

7. Role of OSHA standards for Commercial and Excavation or Construction Worker Exposure Scenarios

   Commercial Guidelines in this document are superseded by OSHA regulations when the exposure stems from the Commercial Facilities own operations and the employer is required by OSHA regulations to train their employees in awareness and protection from the contaminants of concern for a given exposure pathway. OSHA standards and guidelines pertaining to air quality will need to be followed when undertaking trenching activities, even when the construction/excavation worker soil RAGs are met at a site. Air monitoring should be undertaken during construction activities in areas where groundwater exceeds the commercial RAG levels in Table 3, and appropriate action taken when air concentrations exceed OSHA standards.

8. Other Scenarios.

   There are other potential exposure scenarios, but other than the transfer of vapors to trench air (see section VII.E.6 on page 22), generally they will not pose a greater risk than the scenarios presented. However, under unusual circumstances the DEP may determine that other scenarios may be important or the default exposure factors may not be protective at a limited number of sites. These exposure scenarios and exposure factors should be considered on a site-specific basis using the CSM, as illustrated in Figure 1, and a site specific risk assessment conducted using the protocols in the "Guidance Manual for Human Health Risk Assessment at Hazardous Substance Sites" (April 2013).

9. Accessibility of Soil Affects Exposure Scenarios

   The soil depth or a covering may make the soil at a site inaccessible to a person so that the exposure route is not complete. However, future site activities may disturb the soil such that formerly inaccessible deep soils are raised to the land surface, or become accessible if pavement or a building is removed. Generally, accessibility of the soil to potential receptors should be characterized as either "accessible," "potentially accessible," or "isolated" using the following criteria:

   (a) <u>Accessible Soil</u>. Soil is "accessible" if it is located less than two (2) feet below the surface, and the surface are not completely covered by pavement. For buildings having earthen floors, the floor is considered as the soil surface.

   (b) <u>Potentially Accessible Soil.</u> Soil is "potentially accessible" if it is located at a depth of two (2) to 15 feet below the surface (with or without pavement), or if the soil is located less than two (2) feet below intact pavement.

   (c) <u>Isolated Soil.</u> Soil is "isolated" if it is located at a depth greater than 15 feet below the surface, or if the soil is covered completely by a building or other permanent structure that does not have earthen floors, regardless of depth. Soil located at a depth greater than two (2) feet below the earthen floor of a building or other permanent structure is also "isolated."

Consider “potentially accessible” soil as “accessible”, unless an environmental covenant that restricts soil disturbance activities is in place at the site. (See section VII.F.2 on page 24).

F. Exclusion of Pathways

1. General Exclusions

The DEP may approve excluding certain RAG scenarios or exposure pathways at a given site through the procedures developed by the programs identified in section III.A on page 1. Using those program specific procedures, the DEP will determine which exposure scenarios and/or exposure pathways are applicable to the site, based on current and future land use, environmental covenants, and other program requirements. Exposure scenarios and routes of exposure may be excluded if DEP determines that clean-up to a more stringent guideline is not practical and provided that current and all future exposures are precluded by site use restrictions meeting the standards in the Uniform Environmental Covenant Act (“UECA”).

2. Use of Institutional Controls / Environmental Covenants

DEP’s primary objective is to have sites restored so that unrestricted use will not cause excessive risk to site users. However, this is not always practical and sometimes site use restrictions are necessary to protect public health. As an example, environmental covenants can be used to preclude drinking onsite water and residential uses, so that the remedial action goal for soil would be the lesser of the RAGs for the Park User, Outdoor Commercial Worker, and Excavation or Construction Worker scenarios. The environmental covenant must be adequate to prevent residential exposure given the soil clean-up levels, and may include such elements as preventing any future residential development, restricting soil excavation, and/or restricting groundwater withdrawal.

The deed restrictions and environmental covenants must be approved of by the DEP and comply with Maine’s Uniform Environmental Covenant Act (“UECA”), 38 M.R.S.A. § 3001 et seq. UECA templates can be found on the DEP website (http://www.maine.gov/dep/spills/publications/guidance/index.html#new_cov), and usually include the following minimal elements:

1. Notice provisions must provide adequate notification of the environmental covenant(s) to future owners of the property and/or operators at the site. The notice must include the condition(s) imposed by the environmental covenants and clearly define the party responsible for maintaining the environmental covenant.
2. All required oversight and maintenance of any environmental covenant must be enforceable.

3. Environmental covenants must remain protective for the life of the selected remedy.

Environmental covenants where a single authority has control over the land use and/or groundwater is preferred. This can mean property ownership, regulatory permitting, and control of the facilities needed to use the land or groundwater.

3. Exclusion of the Residential Groundwater RAGs.

Subject to applicable RCRA laws, the Department will allow exclusions to obtaining the groundwater guidelines (Table 3) and/or the Leaching to Groundwater RAGs (**Table 1**) when the project lead demonstrates that the groundwater contamination will not have any present or future adverse impact on human health, or water supplies.

a. Exclusion of the groundwater pathway is appropriate when:
    i. The site geology will prevent contaminant migration to or in groundwater.
    ii. The area is served by Public Water and:
        1. No potential or existing Public Water supply sources are located in the contaminant source or potential groundwater plume areas;
        2. Groundwater is non-potable due to the presence of prior contamination. The non-portability must not be caused by a responsible party that owned or operated the site at the time of the contaminant release; and
        3. Environmental covenants approved by the DEP will prevent current and future exposure to contaminated groundwater.
    iii. It is not technically and/or economically feasible to clean up discharges, and passive or active measures, including alternative water supplies and permanent, enforceable environmental covenants, are instituted to permanently mitigate or eliminate current and future exposure; or
    iv. There is a high probability that contaminants will degrade prior to reaching the point of exposure, and a funded contingency plan is in place to remediate the site if area conditions change or new information suggests an imminent exposure potential.

b. The following are examples of situations where the DEP is not likely to approve exclusion of the groundwater pathway:
    i. Environmental Covenants do not prevent exposure to the contaminated groundwater
    ii. There is off-site migration of contamination and area residences or businesses utilize the surrounding aquifer.

iii. The area of the contaminant source and potential groundwater contamination plume is not served by Public Water.
iv. The area of the contaminant source and potential groundwater contamination plume are over or up gradient of a mapped sand and gravel aquifer or high yield bedrock aquifer or a recharge zone for either one.
v. Prior to the discharge, the area of the contaminant source and potential groundwater contamination plume was known to be free of the Contaminant of Potential Concern.
vi. The area of the contaminant source and potential groundwater contamination plume are within any wellhead or source protection area.
vii. Where discharge of contaminated groundwater to the ground surface or surface water causes or may cause a violation of surface water quality standards or otherwise adversely impacts human health or ecological resources.
viii. The area of the contaminant source and potential groundwater contamination plume are within a sole source aquifer. or
ix. The contaminated plume is increasing, not under control, and migrating from the source area.

G. Technical Impracticability Waivers

DEP's goal is to restore contaminated aquifers to drinking water quality whenever possible, and to prevent the spread of further contamination in aquifers. However, in some instances, it is not economically feasible using current technology to restore aquifers to the Maximum Exposure Guidelines found in Table 3. The DEP will make remediation decisions that encourage the development of new remediation technologies, but also recognizes the need to use limited funds wisely. Consistent with EPA's Technical Impracticability (TI) Waiver policies[10], before issuing a TI Waiver DEP will first ensure that the following baseline actions are complete:

1. source control has been completed. That is, localized high concentrations of contaminants in soil and/or groundwater have been treated to levels that will significantly reduce a continuing pollutant load to the aquifer; and
2. Current and future users of the aquifer are not at risk. This may require: an understanding of whether contamination is still spreading in the aquifer, providing alternative water supplies, provisions to mitigate Vapor Intrusion risks, and in some cases operation of active plume containment systems to prevent the spread of contamination. Environmental covenants may be used to help prevent exposure, but alone do not justify a TI waiver.

[10] USEPA OSWER Directive 9283.1-33, "Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration (http://www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf) June 26, 2009.

In addition to the completion of baseline actions, the factors that DEP will consider before granting a TI waiver are:

3. The results of a focused feasibility study of potential treatment options, including cost and the chances of further significant reductions in contamination or of attaining the Table 3 levels; and
4. The resource and people at risk

DEP has concurred with formal TI waivers at the following sites:

1. Two at the former Loring Air Force Base in Limestone,
2. The F. O'Connor Superfund site in Augusta,
3. The McKin Superfund site in Gray, and
4. The Hows Corner Superfund site in Plymouth.

DEP may require a Technology review every 5 years to determine if a new technology is now feasible to remediate contaminated groundwater

VIII. Variances from Default Exposure Factors

In formulating the RAGs, the guidelines were derived using conservative default exposure factors because all potential pathways were not considered, or in the case of dermal contact, cannot be quantified for some contaminants. To employ less conservative exposure assumptions, the site must be adequately characterized and a full risk assessment conducted using the procedures in the Maine "Guidance Manual for Human Health Risk Assessment at Hazardous Substance Sites" (February, 2011).[11]

The default exposure factors used to establish the RAGs are available on the DEP's Remediation Guidelines webpage. In general, DEP has utilized EPA default exposure factors whenever possible, to promote regional consistency. However, in some cases exposure factors more suitable to Maine were substituted, such as the use of a lower exposure frequency for the outside worker to account for the winter months in Maine when the ground is frozen. This provides more realistic target levels that are a bit higher than national standards that are, by default, estimated to be protective of areas where the ground is accessible throughout the year. Since this is not the case in Maine, higher target levels are appropriate and protective of Maine residents and workers.

IX. Technical Help & Technical Basis of the RAGs

A. Technical Assistance

For Technical Assistance, contact your DEP project manager, the DEP program reviewing your proposal (see section III.A on page 1) or the Remediation Division at 207-287-2651.

[11] This Maine specific risk assessment manual was recently revised to closely follow EPA and regional protocols for risk assessment whenever possible. EPA protocols were modified to update science and be more specific to Maine scenarios. For instance, ground is frozen for a good portion of the year in Maine, and is therefore not available for dermal contact. This type of regional specific information is not taken into account in EPA's national guidance, which has to be applicable to all regions of the country.

B. References to Technical Basis

The RAGs were derived based on the revised protocols in the "Guidance for Human Health Risk Assessments for Hazardous Substance Sites in Maine", which was produced by DEP and Maine CDC in June 2009 and updated in 2011. The following technical support documents provide additional information on the calculation methods, factors, assumptions and data that were used to develop the RAG values in **Table 1** through Table 3:

- For the Soil Exposure Pathway, see: Technical Basis and Background for the 2013 Maine Remedial Action Guidelines for Soil Contaminated with Hazardous Substances at: http://www.maine.gov/dep/ftp/RAGS-Background-Documents/
- For the Indoor Air Exposure Pathway, see Appendix A of the Vapor Intrusion Evaluation Guidance 1/14/2010 at: http://www.maine.gov/dep/spills/publications/guidance/rags/vi1-14-2010/1-VI_Guide_1_13_10Final.pdf
- For the Groundwater Exposure Pathway, for the Residential scenario, see the DHHS publication, Procedures for Developing Maximum Exposure Guidelines at: http://www.maine.gov/dhhs/mecdc/environmental-health/eohp/wells/documents/megprocedures2011.pdf. For the Construction/Excavation groundwater scenario, see: Wilcox and Barton, Inc., Development of Construction Worker Groundwater Remedial Action Guidelines (RAGs), June 21, 2012 at: http://www.maine.gov/dep/ftp/RAGS-Background-Documents/

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Figure 1: Example of a Conceptual Site Model with Multiple Pathways

Areas of Concern	Contaminants of Concern	Potential Media Affected	Potential Exposure Routes	Potential Migration Pathways	Receptors
Background	VOCs, PAHs, Petroleum Hydrocarbons	Groundwater		•Groundwater flow from source area through bedrock fractures to water supply wells or surface discharge location south of site •Soil vapor migration from source area through permeable fill soils into Site building or from groundwater plume down-gradient of site into residences	•Humans ingesting contaminated well water •Fresh water aquatic life in surface streams; benthic marine organisms in Unnamed River •Users of on-site building and/or downgradient home owners exposed to indoor air impacts from contaminated soil vapors •Construction or utility workers digging or excavating on-site
AOC-1 Source Area	VOCs, PAHs, Petroleum Hydrocarbons	•Soil, •Groundwater •Soil Vapor	•Inhalation of soil gas vapors •Direct contact with contaminated soil		
AOC-2 Downgradient, On-Site	VOCs, Petroleum Hydrocarbons	Groundwater, Soil Vapor	Inhalation of soil gas vapors		
AOC-3 Downgradient, Off-Site	VOCs, Petroleum Hydrocarbons	Groundwater, Soil Vapor	•Inhalation of soil gas vapors •Ingestion of impacted groundwater •Discharge of contaminated groundwater in habitat of aquatic organisms		

NOTE: For an excel version of the RAG tables 1 through 3, go to:
http://www.maine.gov/dep/spills/publications/guidance/index.html#new_rag

Table 1: Maine Remedial Action Guidelines for the Soil Exposure Pathway, by Exposure Scenario

CAS No Dash	**Chemical**	**Leaching to Ground -water mg/kg)**	**Soil Residential (mg/kg)**	**Soil Park User(mg/Kg)**	**Soil Commercial Worker (mg/kg)**	**Soil Construction Worker**	**Undeveloped ME Background UPL (mg/kg)**	**Rural Developed ME Background UPL (mg/kg)**	**Urban Developed ME Background UPL (mg/kg)**	**Urban Fill ME Background UPL (mg/kg)**
630206	1,1,1,2-Tetrachloroethane	0.20	550	910	1,800	9,300				
71556	1,1,1-Trichloroethane	520	10,000	10,000	10,000	10,000				
79345	1,1,2,2-Tetrachloroethane	0.026	71	120	240	2,200				
79005	1,1,2-Trichloroethane		250	410	830	5,400				
92524	1,1-Biphenyl		8,500	10,000	10,000	10,000				
75343	1,1-Dichloroethane	1.0	2,500	4,200	8,400	10,000				
75354	1,1-Dichloroethene	2.5	8,500	10,000	10,000	10,000				
87616	1,2,3-Trichlorobenzene		1,700	2,800	10,000	420				
120821	1,2,4-Trichlorobenzene	8.6	490	820	1,600	430				
96128	1,2-Dibromo-3-chloropropane		3.2	5.4	47	51				
95501	1,2-Dichlorobenzene	11	5,100	8,500	10,000	10,000				
107062	1,2-Dichloroethane	0.036	160	260	520	3,700				
156592	1,2-Dichloroethene (cis)	0.14	340	570	3,400	6,200				
156605	1,2-Dichloroethene (trans)	2.4	3,400	5,700	10,000	10,000				

CAS No Dash	**Chemical**	**Leaching to Ground -water mg/kg)**	**Soil Residential (mg/kg)**	**Soil Park User(mg/Kg)**	**Soil Commercial Worker (mg/kg)**	**Soil Construction Worker**	**Undeveloped ME Background UPL (mg/kg)**	**Rural Developed ME Background UPL (mg/kg)**	**Urban Developed ME Background UPL (mg/kg)**	**Urban Fill ME Background UPL (mg/kg)**
78875	1,2-Dichloropropane		390	650	1,300	5,500				
528290	1,2-Dinitrobenzene		13	22	100	240				
106990	1,3-Butadiene		4.2	7.0	14	130				
541731	1,3-Dichlorobenzene	0.075	34	57	340	6,200				
142289	1,3-Dichloropropane		3,400	5,700	10,000	10,000				
542756	1,3-Dichloropropene		140	240	480	4,300				
99650	1,3-Dinitrobenzene		13	22	100	120				
106467	1,4-Dichlorobenzene	4.3	2,600	4,400	8,800	10,000				
100254	1,4-Dinitrobenzene		13	22	100	240				
123911	1,4-Dioxane		110	180	290	3,300				
75683	1-Chloro-1,1-difluoroethane		10,000	10,000	10,000	10,000				
93765	2,4,5-T		1,300	2,200	10,000	10,000				
93721	2,4,5-TP		1,100	1,800	8,200	1,900				
95954	2,4,5-Trichlorophenol		10,000	10,000	10,000	10,000				
88062	2,4,6-Trichlorophenol		130	220	1,000	240				
118967	2,4,6-Trinitrotoluene		67	110	510	120				
120832	2,4-Dichlorophenol		400	670	3,100	710				

CAS No Dash	**Chemical**	**Leaching to Ground -water mg/kg)**	**Soil Residential (mg/kg)**	**Soil Park User(mg/Kg)**	**Soil Commercial Worker (mg/kg)**	**Soil Construction Worker**	**Undeveloped ME Background UPL (mg/kg)**	**Rural Developed ME Background UPL (mg/kg)**	**Urban Developed ME Background UPL (mg/kg)**	**Urban Fill ME Background UPL (mg/kg)**
105679	2,4-Dimethylphenol		2,700	4,400	10,000	10,000				
51285	2,4-Dinitrophenol		270	440	2,100	4,800				
121142	2,4-Dinitrotoluene		35	58	93	480				
576261	2,6-Dimethylphenol		80	130	620	1,400				
606202	2,6-Dinitrotoluene		16	26	42	490				
95578	2-Chlorophenol		850	1,400	8,500	2,500				
95487	2-Cresol		6,700	10,000	10,000	10,000				
91576	2-Methylnaphthalene	3.6	500	830	3,600	600		0.16	0.089	0.41
91941	3,3-Dichlorobenzidine		24	40	64	740				
108394	3-Cresol		6,700	10,000	10,000	10,000				
106478	4-Chloroaniline		54	90	140	120				
106445	4-Cresol		670	1,100	5,100	10,000				
83329	Acenaphthene	170	7,500	10,000	10,000	9,800		0.10	0.20	3.5
208968	Acenaphthylene	68	7,500	10,000	10,000	10,000		0.32	0.39	1.4
67641	Acetone		10,000	10,000	10,000	10,000				
75058	Acetonitrile		10,000	10,000	10,000	3,200				
107028	Acrolein		85	140	850	1,200				

CAS No Dash	**Chemical**	**Leaching to Ground -water mg/kg)**	**Soil Residential (mg/kg)**	**Soil Park User(mg/Kg)**	**Soil Commercial Worker (mg/kg)**	**Soil Construction Worker**	**Undeveloped ME Background UPL (mg/kg)**	**Rural Developed ME Background UPL (mg/kg)**	**Urban Developed ME Background UPL (mg/kg)**	**Urban Fill ME Background UPL (mg/kg)**
107131	Acrylonitrile		26	44	88	800				
15972608	Alachlor		190	320	510	2,400				
309002	Aldrin		0.64	1.1	1.7	10				
107051	Allyl chloride		680	1,100	2,300	10,000				
7429905	Aluminum		170,000	280,000	1,000,000	310,000				
120127	Anthracene	2,400	10,000	10,000	10,000	3,800		0.29	0.40	6.7
7440360	Antimony		68	110	680	120	0.71			
12674112	Aroclor 1016		4.9	8.2	12	46				
7440382	Arsenic		1.4	2.3	4.2	42	16			
1912249	Atrazine		47	78	120	710				
7440393	Barium		10,000	10,000	10,000	10,000	470			
71432	Benzene	0.51	85	140	850	150				
56553	Benzo(a)anthracene	10,000	2.6	4.4	35	430		0.86	1.6	27
50328	Benzo(a)pyrene	10,000	0.26	0.44	3.5	43		1.5	1.7	5.2
205992	Benzo(b)fluoranthene	10,000	2.6	4.4	35	430		1.3	2.0	6.8
191242	Benzo(g,h,i)perylene	10,000	3,700	6,200	10,000	10,000		0.57	0.79	16
207089	Benzo(k)fluoranthene	10,000	26	44	350	4,300		0.69	0.76	12

CAS No Dash	**Chemical**	**Leaching to Ground -water mg/kg)**	**Soil Residential (mg/kg)**	**Soil Park User(mg/Kg)**	**Soil Commercial Worker (mg/kg)**	**Soil Construction Worker**	**Undeveloped ME Background UPL (mg/kg)**	**Rural Developed ME Background UPL (mg/kg)**	**Urban Developed ME Background UPL (mg/kg)**	**Urban Fill ME Background UPL (mg/kg)**
65850	Benzoic acid		10,000	10,000	10,000	10,000				
100447	Benzyl chloride		83	140	280	620				
7440417	Beryllium		340	570	3,400	620	2.4			
111444	Bis(2-chloroethyl)ether		10	16	26	250				
117817	Bis(2-Ethylhexyl)phthalate		770	1,300	2,100	10,000				
75274	Bromodichloromethane		230	380	770	6,200				
75252	Bromoform		1,400	2,300	3,600	10,000				
74839	Bromomethane		240	400	2,400	930				
85687	Butyl benzyl phthalate		5,700	9,500	10,000	10,000				
DEP2041	C11-C22 Aromatics	460	750	1,200	5,500	10,000				
DEP2042	C19-C36 Aliphatics	10,000	10,000	10,000	10,000	10,000				
DEP2038	C5-C8 Aliphatics	1,600	1,400	2,300	10,000	10,000				
DEP2040	C9-C10 Aromatics	75	750	1,200	5,500	10,000				
DEP2039	C9-C12 Aliphatics	10,000	2,700	4,400	10,000	10,000				
DEP2043	C9-C18 Aliphatics	10,000	2,700	4,400	10,000	10,000				
7440439	Cadmium		11	18	94	19	0.26			
86748	Carbazole		540	900	1,400	10,000				0.53

CAS No Dash	Chemical	Leaching to Ground -water mg/kg)	Soil Residential (mg/kg)	Soil Park User(mg/Kg)	Soil Commercial Worker (mg/kg)	Soil Construction Worker	Undeveloped ME Background UPL (mg/kg)	Rural Developed ME Background UPL (mg/kg)	Urban Developed ME Background UPL (mg/kg)	Urban Fill ME Background UPL (mg/kg)
75150	Carbon disulfide		10,000	10,000	10,000	10,000				
56235	Carbon tetrachloride	0.55	200	340	680	2,800				
57749	Chlordane		36	60	110	170				
115286	Chlorendic acid		120	200	320	3,700				
108907	Chlorobenzene	1.1	3,400	5,700	10,000	10,000				
67663	Chloroform		460	760	1,500	10,000				
74873	Chloromethane		10,000	10,000	10,000	10,000				
16065831	Chromium (+3)		10,000	10,000	10,000	10,000				
18540299	Chromium (+6)		510	850	5,100	2,800				
218019	Chrysene	10,000	260	440	3,500	10,000		1.0	2.3	6.4
7440484	Cobalt		51	85	510	920	15			
7440508	Copper		2,400	4,000	10,000	4,300	23			
57125	Cyanide		100	170	1,000	1,900				
72548	DDD		45	75	120	1,400				
72559	DDE		32	53	85	980				
50293	DDT		38	64	120	140				
53703	Dibenz(a,h)anthracene	10,000	0.26	0.44	3.5	43		0.32	0.23	4.5

CAS No Dash	**Chemical**	**Leaching to Ground -water mg/kg)**	**Soil Residential (mg/kg)**	**Soil Park User(mg/Kg)**	**Soil Commercial Worker (mg/kg)**	**Soil Construction Worker**	**Undeveloped ME Background UPL (mg/kg)**	**Rural Developed ME Background UPL (mg/kg)**	**Urban Developed ME Background UPL (mg/kg)**	**Urban Fill ME Background UPL (mg/kg)**
132649	Dibenzofuran		130	220	1,000	950				
124481	Dibromochloromethane		170	280	560	4,300				
84742	Dibutyl phthalate		10,000	10,000	10,000	10,000				
75718	Dichlorodifluoromethane		10,000	10,000	10,000	10,000				
60571	Dieldrin		0.68	1.1	1.8	21				
84662	Diethyl phthalate		10,000	10,000	10,000	10,000				
88857	Dinoseb		130	220	1,000	240				
1746016	Dioxin-Like Compounds - TEQ		0.00010	0.00017	0.00031	0.0031				
115297	Endosulfan		800	1,300	6,200	1,400				
72208	Endrin		40	67	310	480				
75003	Ethyl chloride		1,700	2,800	10,000	10,000				
100414	Ethylbenzene	0.81	1,300	2,200	4,300	10,000				
106934	Ethylene dibromide		7.1	12	24	180				
206440	Fluoranthene	10,000	5,000	8,300	10,000	10,000		2.0	3.2	10
86737	Fluorene	120	5,000	8,300	10,000	10,000		0.22	0.29	4.4
76448	Heptachlor		1.3	2.2	6.4	24				
1024573	Heptachlor epoxide		1.2	2.0	3.2	3.1				

CAS No Dash	**Chemical**	**Leaching to Ground -water mg/kg)**	**Soil Residential (mg/kg)**	**Soil Park User(mg/Kg)**	**Soil Commercial Worker (mg/kg)**	**Soil Construction Worker**	**Undeveloped ME Background UPL (mg/kg)**	**Rural Developed ME Background UPL (mg/kg)**	**Urban Developed ME Background UPL (mg/kg)**	**Urban Fill ME Background UPL (mg/kg)**
118741	Hexachlorobenzene		6.8	11	18	190				
87683	Hexachlorobutadiene		130	220	370	240				
319846	Hexachlorocyclohexane, alpha (alpha-BHC)		1.7	2.9	4.6	53				
319857	Hexachlorocyclohexane, beta (beta-BHC)		6.0	10	16	140				
58899	Hexachlorocyclohexane, gamma (Lindane)		0.61	1.0	5.4	2.8				
67721	Hexachloroethane		93	160	720	2,400				
121824	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)		98	160	260	3,000				
193395	Indeno(1,2,3-cd)pyrene	10,000	2.6	4.4	35	430		0.40	0.74	3.3
7439896	Iron		120,000	200,000	1,000,000	220,000				
7439921	Lead	10,000	340	530	1,100	950	32			
121755	Malathion		2,700	4,400	10,000	4,800				
7439965	Manganese		4,100	6,800	10,000	7,400	840			
7487947	Mercuric chloride & other inorganic mercury compounds		51	85	510	930				
72435	Methoxychlor		670	1,100	5,100	1,200				
78933	Methyl ethyl ketone		10,000	10,000	10,000	10,000				
108101	Methyl isobutyl ketone		10,000	10,000	10,000	10,000				

CAS No Dash	**Chemical**	**Leaching to Ground -water mg/kg)**	**Soil Residential (mg/kg)**	**Soil Park User(mg/Kg)**	**Soil Commercial Worker (mg/kg)**	**Soil Construction Worker**	**Undeveloped ME Background UPL (mg/kg)**	**Rural Developed ME Background UPL (mg/kg)**	**Urban Developed ME Background UPL (mg/kg)**	**Urban Fill ME Background UPL (mg/kg)**
80626	Methyl methacrylate		10,000	10,000	10,000	10,000				
1634044	Methyl tert-butyl ether	0.19	5,100	8,500	10,000	10,000				
75092	Methylene chloride		1,000	1,700	10,000	10,000				
7439987	Molybdenum		850	1,400	8,500	1,500	0.98			
91203	Naphthalene	1.7	2,500	4,200	10,000	10,000		0.11	0.22	0.82
7440020	Nickel		510	850	5,100	930	39			
106945	n-Propyl bromide		190	310	1,400	710				
2691410	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)		6,700	10,000	10,000	10,000				
117840	Octyl Phthalate, di-n-		1,600	2,700	10,000	2,900				
56382	Parathion		800	1,300	6,200	1,400				
1336363	PCBs		2.4	4.1	12	6.5				
87865	Pentachlorophenol		20	33	45	620				
14797730	Perchlorate		20	34	200	37				
85018	Phenanthrene	97	3,700	6,200	10,000	8,900		0.83	1.6	6.1
108952	Phenol		10,000	10,000	10,000	10,000				
129000	Pyrene	10,000	3,700	6,200	10,000	10,000		2.0	2.8	9.5
7782492	Selenium						0.61			

CAS No Dash	**Chemical**	**Leaching to Ground -water mg/kg)**	**Soil Residential (mg/kg)**	**Soil Park User(mg/Kg)**	**Soil Commercial Worker (mg/kg)**	**Soil Construction Worker**	**Undeveloped ME Background UPL (mg/kg)**	**Rural Developed ME Background UPL (mg/kg)**	**Urban Developed ME Background UPL (mg/kg)**	**Urban Fill ME Background UPL (mg/kg)**
			850	1,400	8,500	1,500				
7440224	Silver		850	1,400	8,500	1,500				
100425	Styrene		10,000	10,000	10,000	10,000				
127184	Tetrachloroethene	2.7	1,000	1,700	10,000	10,000				
298022	Thimet (Phorate)		27	44	210	48				
108883	Toluene	8.1	10,000	10,000	10,000	10,000				
79016	Trichloroethene	0.23	85	140	850	140				
75694	Trichlorofluoromethane		10,000	10,000	10,000	10,000				
7440622	Vanadium		1,200	2,000	10,000	2,200	100			
108054	Vinyl acetate		10,000	10,000	10,000	10,000				
593602	Vinyl bromide		10,000	10,000	10,000	1,300				
75014	Vinyl chloride	0.013	0.48	0.49	66	600				
1330207	Xylene	26	10,000	10,000	10,000	10,000				
7440666	Zinc		10,000	10,000	10,000	10,000	100			

Table 2: Maine Remedial Action Guidelines for the Indoor Air Exposure Pathway, by Exposure Scenario)

CAS Number No Dash	Chemical	Indoor Air Residential (ug/m3) 2012	Indoor Air Notes 2012	Indoor Air Commercial (ug/m3) 2012
630206	1,1,1,2-Tetrachloroethane	3.3	(c)	17
71556	1,1,1-Trichloroethane	5,200		22,000
79345	1,1,2,2-Tetrachloroethane	0.42	(c)	2.1
79005	1,1,2-Trichloroethane	1.5	(c)	7.7
75343	1,1-Dichloroethane	520		2,200
75354	1,1-Dichloroethene	210	(c)	880
87616	1,2,3-Trichlorobenzene	2.1	(d)	8.8
120821	1,2,4-Trichlorobenzene	2.1		8.8
96128	1,2-Dibromo-3-chloropropane	0.0016		0.020
95501	1,2-Dichlorobenzene	210	(c)	880
107062	1,2-Dichloroethane	0.94	(c)	4.7
156592	1,2-Dichloroethene (cis)	63	(e)	260
156605	1,2-Dichloroethene (trans)	63		260
78875	1,2-Dichloropropane	2.4		12
106990	1,3-Butadiene	0.81		4.1
542756	1,3-Dichloropropene	6.1		31
106467	1,4-Dichlorobenzene	63		260
123911	1,4-Dioxane	3,100	(c)	13,000
75683	1-Chloro-1,1-difluoroethane	52,000		220,000
91576	2-Methylnaphthalene	3.1	(f)	13
83329	Acenaphthene	3.1	(f)	13
67641	Acetone	32,000		140,000
75058	Acetonitrile	63		260
107028	Acrolein	0.37		1.5
107131	Acrylonitrile	0.36		1.8
107051	Allyl chloride	1.0	(c)	4.4
12674112	Aroclor 1016	0.043		0.22
71432	Benzene	3.1		16
100447	Benzyl chloride	1.0	(c)	4.4
111444	Bis(2-chloroethyl)ether	0.074		0.37
75252	Bromoform	22	(c)	110
74839	Bromomethane	5.2		22
DEP2038	C5-C8 Aliphatics	630		2,600
DEP2040	C9-C10 Aromatics	52		220
DEP2039	C9-C12 Aliphatics	210		880
75150	Carbon disulfide	730		3,100
56235	Carbon tetrachloride	4.1		20
108907	Chlorobenzene	1,000		4,400
67663	Chloroform	1.1	(c)	5.3

CAS Number No Dash	Chemical	Indoor Air Residential (ug/m3) 2012	Indoor Air Notes 2012	Indoor Air Commercial (ug/m3) 2012
74873	Chloromethane	94		390
124481	Dibromochloromethane	0.90		4.5
75718	Dichlorodifluoromethane	210		880
75003	Ethyl chloride	10,000		44,000
100414	Ethylbenzene	9.7		49
106934	Ethylene dibromide	0.041		0.20
76448	Heptachlor	0.019	(c)	0.09
118741	Hexachlorobenzene	0.053	(c)	0.27
87683	Hexachlorobutadiene	1.1	(c)	5.6
67721	Hexachloroethane	31	(c)	130
7439976	Mercury (elemental)	0.31		1.3
78933	Methyl ethyl ketone	5,200		22,000
108101	Methyl isobutyl ketone	3,100		13,000
80626	Methyl methacrylate	730		3,100
1634044	Methyl tert-butyl ether	94		470
75092	Methylene chloride	630		2,600
91203	Naphthalene	0.72		3.6
106945	n-Propyl bromide	5.2	(g)	22
1336363	PCBs	0.043	(c)	0.22
85018	Phenanthrene	3.1	(f)	13
100425	Styrene	310		1,300
127184	Tetrachloroethene	42		180
108883	Toluene	5,200		22,000
79016	Trichloroethene	2.1		8.8
75694	Trichlorofluoromethane	730	(c)	3,100
108054	Vinyl acetate	210		880
593602	Vinyl bromide	0.76		3.8
75014	Vinyl chloride	2.8		28
1330207	Xylene	100	(h)	440

IAT Notes	2012 IAT Notes Description
(b)	The indoor air targets are based on the lesser of a Hazard Quotient of 1 or an Incremental Lifetime Cancer Risk of 1E-05.
(c)	Because the unit risk for this compound is based on oral data, there is increased uncertainty associated with its indoor air target.
(d)	Naphthalene RfC used as a surrogate for the noncancer toxicity of this compound
(e)	trans-1,2-Dichloroethene used as a surrogate for cis-1,2-dichloroethene
(f)	The xylene indoor air target should be compared to the sum of the xylene isomer analytical results.
IRIS	IRIS - Integrated Risk Information System; July, 2012
CA-OEHHA	CA-OEHHA - California Office of Environmental Health Hazard Assessment; May 2011
ATSDR	ATSDR - Agency for Toxic Substances and Disease Registry; December 2010

IAT Notes	2012 IAT Notes Description
PPRTV	PPRTV - Provisional Peer-Reviewed Toxicity Values (developed by Superfund Technical Support Center); May 2011
HEAST	HEAST - Health Effects Assessment Summary Tables; July 1997
MassDEP	MassDEP - Massachusetts Department of Environmental Protection; 2008
*	Surrogate toxicity value used for this compound (Naphthalene RfC used as a surrogate for 2-methylnaphthalene and trans-1,2-Dichloroethene RfC used as a surrogate for cis-1,2-dichloroethene)
**	Adjusted by MeCDC to account for additional uncertainty in the value provided by the original source
***	Adjusted by MeCDC to remove subchronic-to-chronic uncertainty factor
****	This value is based on oral data, increasing the uncertainty associated with its value

Table 3: Maine Remedial Action Guidelines for the Groundwater Exposure Pathway by Exposure Scenario

Cas no dash	CHEMICAL	Groundwater Residential (ppb)	Groundwater Construction Worker (ppb)
87616	1,2,3-Trichlorobenzene		7.1
83329	Acenaphthene	400	12
208968	Acenaphthylene		14
135410207	Acetamiprid	500	
34256821	Acetochlor	10	
67641	Acetone	6,000	160,000
75058	Acetonitrile		580,000
107028	Acrolein	4	10
79061	Acrylamide	0.7	
107131	Acrylonitrile	0.6	5.4
15972608	Alachlor	6	33,000
116063	Aldicarb	7	
1646884	Aldicarb sulfone	7	
309002	Aldrin	0.02	2.1
107051	Allyl chloride	20	22
7429905	Aluminum	7,000	9,200,000
834128	Ametryn	60	
7664417	Ammonia	30,000	
7773060	Ammonium sulfamate	1,000	
120127	Anthracene	2,000	20
7440360	Antimony	3	3,700
12674112	Aroclor 1016		39
7440382	Arsenic	10	1,400
3337711	Asulam	40	
1912249	Atrazine	2	17,000
86500	Azinophos - methyl	10	
7440393	Barium	1,000	1,800,000
114261	Baygon (propoxur)	30	
25057890	Bentazon	200	
71432	Benzene	4	44
56553	Benzo(a)anthracene	0.5	120
50328	Benzo(a)pyrene	0.05	15
205992	Benzo(b)fluoranthene	0.5	250
191242	Benzo(g,h,i)perylene		14,000
207089	Benzo(k)fluoranthene	5	1,200
65850	Benzoic Acid	30,000	28,000,000
100447	Benzyl chloride	2	3.2
7440417	Beryllium	10	18,000
92524	Biphenyl (1,1-)	400	1.5
108601	bis-2-Chloro isopropyl ether	300	
111444	bis-2-Chloroethyl ether	0.3	11,000
7440428	Boron	1,000	
188425856	Boscalid	200	
314409	Bromacil	70	
74975	Bromochloromethane	100	

Cas no dash	CHEMICAL	Groundwater Residential (ppb)	Groundwater Construction Worker (ppb)
75274	Bromodichloromethane	6	130
75252	Bromoform	40	5,600
74839	Bromomethane	10	490
106990	Butadiene (1,3-)	0.1	3.7
85687	Butyl benzyl phthalate	200	690,000
2008415	Butylate	400	
DEP2041	C11-C22 Aromatics	200	1,600
DEP2042	C19-C36 Aliphatics	10,000	59,000,000
DEP2038	C5-C8 Aliphatics	300	490
DEP2040	C9-C10 Aromatics	200	1,400
DEP2039	C9-C12 Aliphatics	700	1,800
DEP2043	C9-C18 Aliphatics	700	1,900
7440439	Cadmium	1	650
133062	Captan	200	
63252	Carbaryl	70	
86748	Carbazole		110,000
1563662	Carbofuran	40	
75150	Carbon disulfide	600	4,600
56235	Carbon tetrachloride	5	310
5234684	Carboxin	700	
302170	Chloral hydrate	70	
133904	Chloramben (Amiben)	100	
10599903	Chloramine	700	
14866683	Chlorate	7	
57749	Chlordane		45
12789036	Chlordane/Nonachlor	1	
115286	Chlorendic Acid	4	99,000
10049044	Chlorine dioxide	200	
7758192	Chlorite	200	
106478	Chloroaniline (4-)	2	3,600
108907	Chlorobenzene	100	2,700
67663	Chloroform	70	170
74873	Chloromethane	20	
95578	Chlorophenol (2-)	40	49,000
1897456	Chlorothalonil	100	
95498	Chlorotoluene (2- or ortho-)	100	370,000
106434	Chlorotoluene (4- or para-)	500	
2921882	Chlorpyrifos	7	
7440473	Chromium (total)	20	
16065831	Chromium III	10,000	14,000,000
18540299	Chromium VI (soluble salts)	20	78,000
218019	Chrysene	50	4,200
7440484	Cobalt	10	29,000
7440508	Copper	500	130,000
21725462	Cyanazine	1	
57125	Cyanide	4	55,000
1861321	Dacthal (DCPA)	70	
75990	Dalapon	200	
72548	DDD	1	410

Cas no dash	CHEMICAL	Groundwater Residential (ppb)	Groundwater Construction Worker (ppb)
72559	DDE	1	95
50293	DDT	1	24
103231	Di-(2-ethylhexyl)adipate	300	
117817	Di-(2-ethylhexyl)phthalate (PAE)	30	2,200
2303164	Diallate (Avadex)	6	
333415	Diazinon	5	
53703	Dibenz(a,h)anthracene	0.05	7.3
132649	Dibenzofuran		3,700
96128	Dibromo-3-chloropropane (1,2-) (DBCP)	0.4	1.2
124481	Dibromochloromethane	4	200
84742	Dibutylphthalate	700	100,000
1918009	Dicamba	200	
1194656	Dichlobenil	9	
2008584	Dichlorobenzamide (2,6-) (BAM)	10	
95501	Dichlorobenzene (1,2- or ortho)	200	6,300
541731	Dichlorobenzene (1,3- or meta)	1	36,000
106467	Dichlorobenzene (1,4- or para-)	70	400
91941	Dichlorobenzidine (3,3-)	0.8	9,600
75718	Dichlorodifluoromethane	1,000	5,500
75343	Dichloroethane (1,1-)	60	2,200
107062	Dichloroethane (1,2-)	4	140
75354	Dichloroethylene (1,1-)	40	500
156592	Dichloroethylene (cis-1,2-)	10	2,000
156605	Dichloroethylene (trans-1,2-)	100	2,000
75092	Dichloromethane	40	2,600
120832	Dichlorophenol (2,4-)	20	9,900
94757	Dichlorophenoxyacetic acid (2,4-)	70	
78875	Dichloropropane (1,2-)	10	82
142289	Dichloropropane (1,3-)	100	1,300,000
542756	Dichloropropene (1,3-)	4	110
60571	Dieldrin	0.02	7.3
84662	Diethyl phthalate (PAE)	6,000	39,000,000
1445756	Diisopropyl methylphosphonate	600	
68122	Dimethylformamide (N,N-)	700	
105679	Dimethylphenol (2,4-)	100	270,000
576261	Dimethylphenol (2,6-)	4	31,000
528290	Dinitrobenzene (1,2- or ortho)	0.7	7,900
99650	Dinitrobenzene (1,3- or meta)	0.7	4,200
100254	Dinitrobenzene (1,4- or para)	0.7	8,400
51285	Dinitrophenol (2,4-)	10	160,000
121142	Dinitrotoluene (2,4-)	1	15,000
606202	Dinitrotoluene (2,6-)	0.5	3,100
88857	Dinoseb	7	2,800
123911	Dioxane (1,4-)	4	72,000
957517	Diphenamid	200	
122394	Diphenylamine	200	
85007	Diquat	20	
298044	Disulfoton	0.3	

Cas no dash	CHEMICAL	Groundwater Residential (ppb)	Groundwater Construction Worker (ppb)
505293	Dithiane (1,4-)	70	
330541	Diuron	10	
115297	Endosulfan	40	25,000
145733	Endothall	100	
72208	Endrin	2	1,500
106898	Epichlorohydrin	40	
75003	Ethyl chloride	7	20,000
100414	Ethylbenzene	30	1,500
106934	Ethylene dibromide (EDB)	0.2	8.7
107211	Ethylene glycol	10,000	
111762	Ethylene glycol monobutyl ether	700	
96457	Ethylene thiouria (ETU)	0.6	
22224926	Fenamiphos	2	
2164172	Fluometuron	90	
206440	Fluoranthene	300	100,000
86737	Fluorene	300	15
7782414	Fluoride	2,000	
75694	Fluorotrichloromethane	2,000	20,000
59756604	Fluridone	600	
133073	Folpet	100	
944229	Fonofos	10	
50000	Formaldehyde	100	2,900
1071836	Glyphosate	700	
76448	Heptachlor	0.07	5.5
1024573	Heptachlor epoxide	0.04	8.2
118741	Hexachlorobenzene	0.2	12
87683	Hexachlorobutadiene	4	250
319846	Hexachlorocyclohexane (alpha-)	0.06	16
319857	Hexachlorocyclohexane (beta-)	0.2	800
58899	Hexachlorocyclohexane (gamma-) (Lindane)	0.03	29
77474	Hexachlorocyclopentadiene	40	
67721	Hexachloroethane	5	1,100
70304	Hexachlorophene	2	
110543	Hexane (n-)	400	
51235042	Hexazinone	200	
2691410	HMX (cyclo-tetramethylenetetranitramine)	400	480,000
138261413	Imidacloprid	400	
193395	Indeno(1,2,3-cd)pyrene	0.5	77
20461545	Iodide	300	
7439896	Iron	5,000	6,500,000
78591	Isophorone	400	
1832548	Isopropylmethylphosphonate	700	
99876	Isopropyltoluene (p-cymene)	70	
7439921	Lead	10	1,600,000
121755	Malathion	100	140,000
123331	Maleic hydrazide	4,000	
8018017	Mancozeb	6	
12427382	Maneb	6	

Cas no dash	CHEMICAL	Groundwater Residential (ppb)	Groundwater Construction Worker (ppb)
7439965	Manganese	500	220,000
94746	MCPA (2-Methyl-4-chlorophenoxyacetic acid)	4	
7439976	Mercury (elemental)		1,500
7487947	Mercury (mercuric chloride)	2	28,000
104206828	Mesotrione	50	
57837191	Metalaxyl	400	
67561	Methanol	4,000	
16752775	Methomyl	200	
72435	Methoxychlor	40	3,500
161050584	Methoxyfenozide	700	
78933	Methyl ethyl ketone	4,000	22,000
108101	Methyl isobutyl ketone	500	11,000
80626	Methyl methacrylate	10,000	2,100
298000	Methyl parathion	2	
1634044	Methyl tert butyl ether (MTBE)	40	7,800
91576	Methylnaphthalene (2-)	30	10
95487	Methylphenol (2-)	40	170,000
108394	Methylphenol (3-)	40	220,000
106445	Methylphenol (4-)	4	200,000
51218452	Metolachlor	100	
21087649	Metribuzin	200	
7439987	Molybdenum	40	46,000
91203	Naphthalene	10	9.7
15299997	Napropamide	800	
7440020	Nickel (soulble salts)	20	28,000
14797558	Nitrate (as N)	10,000	15,000,000
14797650	Nitrite (as N)	1,000	
98953	Nitrobenzene	1	
556887	Nitroguanidine	700	
100027	Nitrophenol (p-)	60	
27314132	Norflurazon	10	
106945	n-Propyl bromide		550
117840	Octyl Phthalate, di-n-		120
23135220	Oxamyl (Vydate)	200	
1910425	Paraquat	3	
56382	Parathion	4	16,000
82688	PCNB (pentachloronitrobenzene)	2	
87865	Pentachlorophenol	0.9	1,400
14797730	Perchlorate	0.8	1,200
1763231	Perfluorooctane sulphonic acid	0.1	
335671	Perfluorooctanoic acid	0.06	
85018	Phenanthrene		23
108952	Phenol	2,000	240,000
298022	Phorate	1	600
1918021	Picloram	500	
1336363	Polychlorinated biphenyls (PCBs)	0.5	0.93
1610180	Prometon	100	
7287196	Prometryn	30	

Cas no dash	CHEMICAL	Groundwater Residential (ppb)	Groundwater Construction Worker (ppb)
23950585	Pronamide	10	
1918167	Propachlor	90	
709988	Propanil	40	
139402	Propazine	100	
122429	Propham	100	
60207901	Propiconazole	9	
57556	Propylene glycol	100,000	
129000	Pyrene	200	120,000
10043922	Radon		
121824	RDX (1,3,5-trinitro-1,3,5-triazine)	3	120,000
108463	Resorcinol (1,3-Benzenediol)	100	
83794	Rotenone	30	
7782492	Selenium	40	46,000
7440224	Silver	40	47,000
122349	Simazine	4	
7440235	Sodium	20,000	
7440246	Strontium	4,000	
100425	Styrene	100	2,400
112410238	Tebufenozide	100	
34014181	Tebuthiuron	500	
5902512	Terbacil	90	
13071799	Terbufos	0.2	
1746016	Tetrachlorodibenzo-p-dioxin (2,3,7,8-)	0.000003	0.00020
630206	Tetrachloroethane (1,1,1,2-)	10	630
79345	Tetrachloroethane (1,1,2,2-)	2	41,000
127184	Tetrachloroethylene	40	880
109999	Tetrahydrofuran	600	
7791120	Thallium (chloride)	0.6	
7440280	Thallium (soluble salts)		92
137268	Thiram	40	
108883	Toluene	600	12,000
8001352	Toxaphene	0.3	
101200480	Tribenuron methyl	6	
120821	Trichlorobenzene (1,2,4-)	70	7.0
108703	Trichlorobenzene (1,3,5-)	40	
71556	Trichloroethane (1,1,1-)	10,000	15,000
79005	Trichloroethane (1,1,2-)	6	0.62
79016	Trichloroethylene	4	5.8
95954	Trichlorophenol (2,4,5-)	700	1,800,000
88062	Trichlorophenol (2,4,6-)	7	1,900
93765	Trichlorophenoxyacetic acid (2,4,5-)	70	380,000
93721	Trichlorophenoxypropionic acid (2,4,5-)	60	19,000
96184	Trichloropropane (1,2,3-)	0.01	
55335063	Triclopyr acid	400	
1582098	Trifluralin	50	
55630	Trinitroglycerol (nitroglycerin)	5	
88891	Trinitrophenol (2,4,6-)	60	
118967	Trinitrotoluene (2,4,6-)	4	4,300

Cas no dash	CHEMICAL	Groundwater Residential (ppb)	Groundwater Construction Worker (ppb)
13674878	Tris (1,3-dichloroisopropyl) phosphate	10	
7440611	Uranium	20	
7440622	Vanadium	200	65,000
108054	Vinyl acetate	7,000	520
75014	Vinyl Chloride	0.2	160
7723140	White Phosphorous	0.1	
1330207	Xylenes	1,000	790
7440666	Zinc	2,000	2,800,000
12122677	Zineb	400	
137304	Ziram	4	